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Factors Influencing Plant Propagation Efficiency Via Stem Cuttings

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Abstract: The work aimed to study all the possible factors affecting efficiency of plant propagation via stem cuttings. Several factors including type of cutting, culture medium, type and concentration of growth regulators were investigated. These factors were studied on *Ficus hawaii* as woody tree and *Chrysanthemum morifolium* as herbaceous plant to investigate the effect of plant type factor. All experiments were performed under plastic house conditions to achieve the objectives of work. It was found that all studied factors are very effective for plant production and growth. Intermediate cuttings were found to be more suitable than terminal ones for the propagation of ficus. Peat moss and sand media showed significantly higher survival, rooting and growth compared to perlite and the mixture 1:1:1 of the three media. Treatment of cuttings by indole acetic acid (IAA) was more effective than treatment by either indole butyric acid (IBA) or naphthyl acetic acid (NAA). The treatment of cuttings by growth regulators was essential where all studied concentrations were better than control and 50 ppm was the best concentration. Response of chrysanthemum to culture media was different from that of ficus where the mixture and perlite media gave significantly better results than peat moss and sand media which proves the importance of plant type factor. Therefore, the optimum propagation efficiency of ficus can be obtained by the cultivation of intermediate cuttings in peat moss after treating by 50 ppm of IAA. For chrysanthemum, the optimum propagation efficiency can be obtained by the cultivation of terminal cuttings in a mixture 1:1:1 of peat moss, sand and perlite after treating by 50 ppm of IAA. The obtained results showed the effectiveness of several factors on propagation of woody and herbaceous plants. It should be of great importance on both applied level for mass production of plants and fundamental level for understanding plant propagation process.

Key words: Ficus · Chrysanthemum · Cuttings · Propagation · Media · Growth regulators · Concentration · Woody · Herbaceous

INTRODUCTION

Stem cutting is the most frequent method used for vegetative propagation of many plant species from herbaceous to woody plants. Success of propagation via stem cuttings is usually affected by many factors including the status of mother plant or cutting source, type of culture medium, type of cutting, rooting hormones and environmental conditions, as light, temperature, air humidity and soil moisture, during propagation.

Most reports concentrated on the effect of certain factors on plant production via cuttings for one specie or similar species. Premixed formulations containing plant growth factors including the hormones indole-3-butyric acid and paclobutrazol, the nutrients N, P, K and trace elements and the protecting agent Sportac, improved rooting from cuttings and promoted the development of the root system [1]. Growth hormones, rooting media were found to be effective factors for rooting of many plant species [2].

Ficus, as one of the most important tree propagated principally by stem cuttings, is an important woody genus including about 1,000 species distributed in tropical and subtropical regions. Ficus species, as *F. nitida, F. benjamina* and *F. hawaii*, have multiple uses as indoor ornamental plants and garden and roadside trees [3, 4].

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Chrysanthemum is also one of the most important flowering herbaceous plant propagated principally by stem cuttings. It is used as pot flowering plant for interior and exterior decoration in houses and gardens and as famous cut flowers plant. Efforts are still made for the improvement of growth and flowering of this commercially important specie [5].

Few reports are available on the propagation of these two economically and ornamentally important genus from cuttings. Cuttings from micropropagated stock plants of *Ficus benjamina* rooted faster and had a higher rooting percentage than cuttings from traditionally propagated stock plants [6]. For chrysanthemums, three stock plant management systems were investigated for their effect on cutting quality, by varying the number of axillary buds that could grow out and the number of leaves that remained on the plant [7].

To improve production of flowering plants and trees, we set up efficient *in vitro* propagation systems for some flowering species including pelargonium and rose [8, 9]. We also reported on the improvement of seed germination and seedlings growth for some economically important trees [10]. The present work aimed to study all the possible factors influencing plant propagation efficiency via stem cuttings. This study included two different plants, chrysanthemum as herbaceous plant and ficus as woody plant, to investigate the effect of plant type factor.

MATERIALS AND METHODS

This study was conducted under plastic house conditions at the Floriculture Experimental Farm, College of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia during 2012 and 2013. Factors which may affect plant production via stem cuttings were studied in several experiments. They include type of cutting, culture media, type and concentration of growth regulator. Two different plant species including *Chrysanthemum morifolium* as a herbaceous plant and *Ficus hawaii* as a woody plant were used to study the effect of plant type factor on propagation efficiency.

Preparation of Cuttings: Stem cuttings were collected from mother plants grown in pots under plastic house conditions for the two studied species. Terminal or intermediate cuttings of 10 cm including 4-5 buds were taken from new and mature shoots. Cuttings were planted, with or without treatment, in pots filled with various media as described below. Twelve cuttings were cultivated per pot of 30 cm diameter.

Factors Studied: To achieve the aim of work, selected factors were studied in separated experiments. Experiments were carried out on *Chrysanthemun morifolium*, as a herbaceous plant and *Ficus Hawaii*, as a woody plant or tree, to study the effect of plant type factor. Cutting type was also studied where cuttings of similar length (10 cm) including 4-5 buds were taken from either shoot ends (terminal cuttings) or intermediate parts of shoots (intermediate cuttings) for both species. All leaves, except the terminal leaf, were separated from both cutting types before planting. Pots were filled by sand, peatmoss, perlite or an equal mixture (1:1:1, w:w) of the three previous media (mixed). After the irrigation of pots, cuttings were planted directly, 12 cuttings per pot, or after treatment by one of the following growth regulators: (IAA), 3-indole acetic acid (FULKA), (IBA), indole-3-butyric acid (WINLAB), (NAA), 1-naphthyl acetic acid (Riedel-de Haen), or (RP), rooting powder containing IBA (Seradix). Cuttings were dipped in solutions of 0, 50 or 100 ppm of IAA, IBA or NAA for half an hour or in the rooting powder before cultivation. All cultures were kept under plastic house conditions and irrigated similarly when needed.

Experimental Design and Data Collection: All experiments were arranged in a split plot design where two factors were studied in each experiment. Experiments included four replicates and each one was repeated twice. By the end of each experiment, one month after cultivation, survival percentage, rooting percentage, stem length in cm, root length in cm and leaves number per plant were recorded for all studied treatments.

Statistical Analysis: All data were subjected to analysis of variance (ANOVA) to determine significant differences followed by the comparison of means at significant level of 5% using Excel 2010.

RESULTS

Effect of Culture Media and Cutting Type on Ficus: The effect of culture media and cutting type on the propagation efficiency of ficus is shown in Figure (1) and Table (1). Results showed that survival and rooting percentages were significantly higher with intermediate cuttings. However, number of leaves and stem length were higher with terminal cuttings. Regardless of the cutting type, peat moss and sand allowed the highest survival percentage compared to other studied media. Peat moss also showed the highest rooting percentage

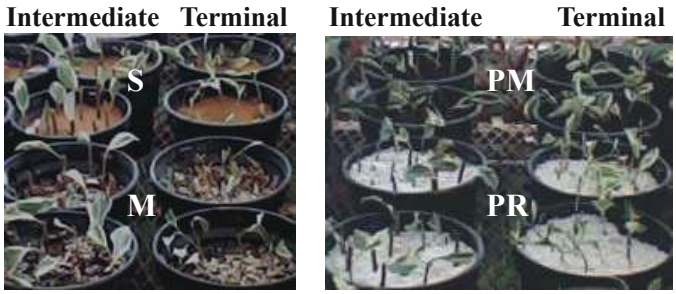

Fig. 1: Growth of terminal and intermediate cuttings of ficus on sand (S), peat moss (PM), perlite (PR) and mixed medium (M)

Table 1: Effect of culture media and cutting type on the production and growth of ficus via cuttings

Culture media	Type of cutting	Survival (%)	Rooting (%)	Leaves (No./Plant)	Stem length (cm)
Sand	---	68.0 a	40.0 b	3.9 a	9.2 a
Peat moss	---	68.5 a	49.0 a	1.9 b	8.2 b
Perlite	---	39.0 b	27.0 c	1.5 b	7.3 c
Mixed	---	43.5 b	36.5 b	2.0 b	8.3 b
---	Terminal	50.5 b	34.0 b	2.8 a	8.6 a
---	Intermediate	59.0 a	42.0 a	1.9 b	7.8 b
Sand	Terminal	70.0 ab	40.0 bc	4.0 a	9.4 a
	Intermediate	66.0 abc	40.0 bc	3.7 a	9.0 ab
Peat moss	Terminal	75.0 a	40.0 bc	2.0 bc	8.5 bc
	Intermediate	62.0 abc	58.0 a	1.7 c	7.8 cd
Perlite	Terminal	20.0 e	24.0 d	2.0 bc	7.5 de
	Intermediate	58.0 bc	30.0 d	1.0 c	7.0 e
Mixed	Terminal	37.0 d	32.0 cd	3.0 ab	9.0 ab
	Intermediate	50.0 cd	41.0 b	1.0 c	7.5 de

Means with similar letter at the same column and part are not significantly different at $\alpha = 0.05$.

and sand gave the highest stem length and leaves number per plant. The least results were obtained with perlite medium. Cultivation of any cutting type in sand or peat moss gave similarly the highest survival percentages. However, significantly higher rooting percentage was observed on intermediate cuttings cultivated in peat moss and significantly higher stem length and leaves number were found with cuttings cultivated in sand. Cultivation of any cutting type in perlite showed the least results.

Effect of Type and Concentration of Growth Regulators on Ficus: Type and concentration of growth regulators affected significantly production and growth of plants via cuttings as shown in Table (2). The treatment of cuttings with indole acetic acid (IAA) before cultivation showed the highest survival, rooting and growth rate compared to the other studied growth regulators. However, the lowest rooting percentage was recorded on cuttings treated by naphthyl acetic acid (NAA). Treatment of cuttings by growth regulators was essential where significantly better survival, rooting and growth were obtained with treated cuttings compared to control. Furthermore, the treatment by 50 ppm permitted significantly better results compared to 100 ppm regardless of the type of growth regulator. Consequently, treatment of cuttings with 50 ppm of growth regulators gave better results compared to other combinations. The best results was obtained when cuttings were treated with 50 ppm of IAA solution before cultivation.

Effect of Culture Media and Type of Growth Regulators on Chrysanthemum: Culture media and type of growth regulators had significant effects on production and growth of chrysanthemum plants via cuttings as shown in Table (3) and Figure (2). Regarding culture media, chrysanthemum cuttings showed different response to culture media compared to ficus where the mixture medium allowed the maximum survival, rooting and growth of cuttings. Perlite also showed good results compared to peat moss and sand. Concerning type of growth regulator, chrysanthemum cuttings responded similarly to growth regulators where IAA and IBA gave significantly better rooting and growth than control. Also, IAA was the best growth regulators for production and growth of plants.

Table 2: Effect of type and concentration of growth regulators on the production and growth of ficus via cuttings

Type of G. R.	Concentration of G. R.	Survival (%)	Rooting (%)	Leaves (No./Plant)	Stem length (cm)
IBA	---	55.0 b	45.0 b	4.0 a	8.7 b
IAA	---	70.0 a	52.5 a	3.7 a	10.4 a
NAA	---	55.0 b	37.5 c	1.7 b	10.2 a
---	Control	42.5 c	27.5 c	2.0 c	9.0 c
---	50 ppm	77.5 a	65.0 a	4.3 a	10.7 a
---	100 ppm	60.0 b	42.5 b	3.0 b	9.5 b
IBA	Control	30.0 e	22.5 c	3.0 bc	8.0 e
	50 ppm	75.0 ab	60.0 a	5.0 a	10.0 bcd
	100 ppm	60.0 bcd	52.5 ab	4.0 ab	8.2 e
IAA	Control	45.0 de	37.5 bc	2.0 cd	9.5 d
	50 ppm	90.0 a	67.5 a	5.0 a	11.2 a
	100 ppm	75.0 ab	52.5 ab	4.0 ab	10.5 abc
NAA	Control	52.5 cd	22.5 c	1.0 d	9.7 cd
	50 ppm	67.5 bc	67.5 a	3.0 bc	10.8 ab
	100 ppm	45.0 de	22.5 c	1.0 d	10.0 bcd

Intermediate cuttings were dipped in growth regulators (G. R.) solutions for 30 min then cultivated in pots filled by mixed media, means with similar letter at the same column and part are not significantly different at $\alpha = 0.05$.

Table 3: Effect of culture media and type of growth regulators on the production and growth of chrysanthemum via cuttings

Culture media	Type of G. R.	Survival (%)	Rooting (%)	Leaves (No./Plant)	Root length (cm)
Sand	---	25.0 c	25.0 c	9.1 b	5.1 c
Peat moss	---	7.5 d	7.5 d	10.3 a	5.7 b
Perlite	---	40.0 b	40.0 b	6.9 c	6.5 a
Mixed	---	52.5 a	52.5 a	9.9 a	6.4 a
---	Control	12.5 c	12.5 c	6.8 b	5.8 b
---	IAA	70.0 a	70.0 a	10.2 a	9.9 a
---	IBA	35.0 b	35.0 b	11.3 a	4.7 b
---	R. P.	7.5 c	7.5 c	3.7 c	1.2 c
Sand	Control	0.0 h	0.0 h	---	---
	IAA	70.0 bc	70.0 bc	7.2 bc	7.5 bc
	IBA	30.0 efg	30.0 efg	11.0 a	2.7 de
	R. P.	0.0 h	0.0 h	---	---
Peat moss	Control	0.0 h	0.0 h	---	---
	IAA	30.0 efg	30.0 efg	10.3 ab	5.7 bcd
	IBA	0.0 h	0.0 h	---	---
	R. P.	0.0 h	0.0 h	---	---
Perlite	Control	10.0 gh	10.0 gh	2.3 d	4.0 cde
	IAA	80.0 ab	80.0 ab	11.0 a	13.3 a
	IBA	60.0 bcd	60.0 bcd	11.3 a	8.2 b
	R. P.	10.0 gh	10.0 gh	2.8 d	0.7 e
Mixed	Control	40.0 def	40.0 def	11.2 a	7.5 bc
	IAA	100.0 a	100.0 a	12.3 a	13.2 a
	IBA	50.0 cde	50.0 cde	11.5 a	3.3 de
	R. P.	20.0 fgh	20.0 fgh	4.5 cd	1.7 e

Terminal cuttings were dipped in IAA or IBA solutions of 50 ppm for 30 min or in rooting powder containing IBA (R.P.), means with similar letter at the same column and part are not significantly different at $\alpha = 0.05$.

However, the treatment of cuttings by the rooting powder (R.P.) containing IBA was ineffective. The highest survival, rooting and growth of cuttings were obtained when cuttings were treated with IAA then cultivated in mixed medium. Similar results were also obtained when cuttings were cultivated in Perlite after treatment by IAA.

Effect of Plant Type: The comparison between the response of ficus, as woody plant and chrysanthemum, as herbaceous plant, to culture media and growth regulators showed a great effect for plant type factor (Table 1, 2, 3). Results showed similar response to growth regulators for both species where IAA was the best growth regulator for

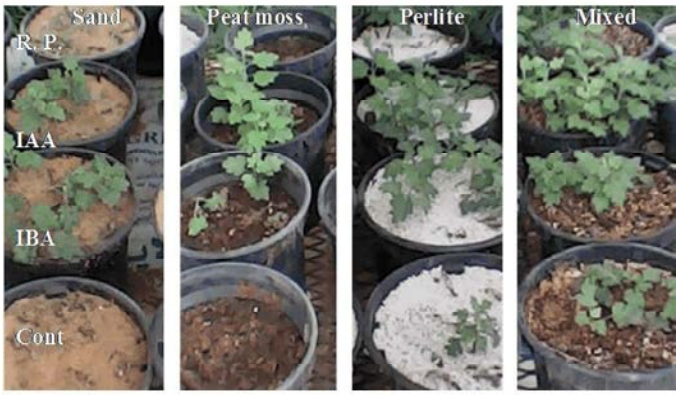

Fig. 2: Growth of chrysanthemum cuttings on different culture media after treatment by different growth regulators

their production and growth. However, Peat moss or sand seemed to be the best media for ficus compared to the perlite or mixed media for chrysanthemum. The best results on ficus were obtained when intermediate cuttings were treated by 50 ppm IAA then cultivated in peat moss medium. The best results on chrysanthemum were obtained when terminal cuttings were treated by 50 ppm IAA then cultivated in mixed medium.

DISCUSSION

Culture media and cutting type were found to be effective factors significantly influencing production and growth of plants via stem cuttings. Comparing the four tested media, peat moss and sand gave significantly better results than perlite. The nature of peat moss and sand as rich, soft and compact media compared to perlite can explain this result. Higher stem length and leaves number was recorded on sand medium. The favorable effect of sand on germination and growth was previously proved on different plant species [10]. Cutting type was also an effective factor where higher survival and rooting percentages but lower stem length and leaves number were obtained with intermediate cuttings compared to terminal ones. The higher rooting capacity resulted from the higher nutrition and humidity content of intermediate cuttings may explain their surviving and rooting. However, the growth speed caused by the presence of apical buds in terminal cuttings may explain their better growth. The cultivation of intermediate cuttings in peat moss was the best treatment. Intermediate cutting is the type widely used for the propagation of woody plants [6]. The role of growth regulators on production of plants via cuttings was previously reported on many plant species [2]. In our study, type of growth regulators was also effective where better survival, rooting and growth was obtained when cuttings were treated by IAA compared to IBA and NAA. Indeed, IAA is a natural growth hormone produced by plants, which may give an explanation to its superiority. Concentration of growth regulators was also an important factor where treatment of cuttings was indispensable which can be related to their well known role on the promotion of rooting. The concentration of 50 ppm was the optimum one and the treatment by 50 ppm of IAA was the recommended treatment. The comparison between the response of ficus and chrysanthemum to similar factors showed the effectiveness of plant type factor. Despite the similar response of ficus and chrysanthemum to groth regulators, their response to culture media was different. The peat moss followed by sand was the best for ficus, whereas, the mixture followed by perlite was the best for chrysanthemum. This result can be explained by the nature of ficus as woody plant and chrysanthemum as herbaceous one. The type of cutting may also be another cause of this difference as previously mentioned.

CONCLUSION

It can be concluded that several factors have important roles in the propagation of plants via stem cutting. Type of cutting, culture media, type and concentration of growth regulator and type of plant were proved to be very effective factors. For ficus, intermediate cuttings were better than terminal ones, peat moss and sand media were better than perlite and mixed media, IAA was better than IBA and NAA and the concentration of 50 ppm was better than control and 100 ppm. Similar response was found with chrysanthemum except for culture media where mixed and perlite media were better than peat moss and sand media which proves the importance of plant type as effective factor distinguishing

between woody and herbaceous plants. Therefore, the optimum results on ficus can be obtained by the cultivation of intermediate cuttings in peat moss after treating by 50 ppm of IAA. The optimum results on chrysanthemum can be obtained by the cultivation of terminal cuttings in a mixture 1:1:1 of peat moss, sand and perlite after treating by 50 ppm of IAA. The obtained results should be of great importance for the propagation of plants via stem cuttings. They should also contribute in the understanding of plant propagation process.

REFERENCES

1. Wiesman, Z., A. Markus, S. Wybraniec, L. Schwartz and D. Wolf, 2002. Promotion of rooting and development of cuttings by plant growth factors formulated into a controlled-release system. Biol. Fertil Soils, 36: 330-334.
2. Akinyele, A.O., 2010. Effects of growth hormones, rooting media and leaf size on juvenile stem cuttings of *Buchholzia coriacea* Engler. Ann. For. Res., 53(2): 127-133.
3. Wagner, W.L., D.R. Herbst and S.H. Sohmer, 1999. Manual of the flowering plants of Hawaii. Bishop Museum Special Publication 83, University of Hawaii and Bishop Museum Press, Honolulu, HI.
4. Hadia, H.A., H.E. El-Mokadem and H.F. El-Tayeb, 2008. Phylogenetic relationship of four *Ficus* species using random amplified polymorphic DNA (RAPD) and inter-simple sequence repeat (ISSR) markers. Journal of Applied Sciences Research, 4(5): 507-514.
5. Habib, A.M. and S.M. Zaghlol, 2012. Effect of chemical, organic and bio-fertilization on growth and flowering of *Chrysanthemum frutescens* Plants. Journal of Horticultural Science & Ornamental Plants 4(2): 186-194.
6. Kristiansen, K., 1991. Post-propagation growth of cuttings from *in vitro* and *in vivo* propagated stock plants of *Ficus benjamina*. Scientia Horticulturae, 46: 315-322.
7. Ruiter, H.A., 1993. Improving cutting quality in chrysanthemum by stock plant management. Scientia Horticulturae, 56: 43-50.
8. Hassanein A. and N. Dorion, 2005. Efficient plant regeneration system from leaf discs of zonal (*Pelargonium* x *hortorum*) and two scented (*P. capitatum* and *P. graveolens*) geraniums. Plant Cell Tissue and Organ Culture, 83: 231-240.
9. Mahmoud I.M.A., A.M.A. Hassanein and N.E. El Keltawi, 2011. Factors affecting in vitro propagation efficiency of hybrid tea rose. American-Eurasian Journal of Agricultural and Environmental Sciences, 11(6): 847-853.
10. Hassanein, A.M.A., 2010. Improving seed germination and seedling growth of some economically important trees by seed treatments and growing media. Journal of Horticultural Sciences and Ornamental Plants, 2(1): 24-31.